ORIGINAL ARTICLE

Are inequalities in height narrowing? Comparing effects of social class on height in two generations

L Li, O Manor, C Power

Arch Dis Child 2004;**89**:1018–1023. doi: 10.1136/adc.2003.035162

See end of article for authors' affiliations

Correspondence to: L Li, Centre for Paediatric Epidemiology and Biostatistics, Institute of Child Health, 30 Guilford Street, WC1N 1EH London, UK; lli@ich.ucl.ac.uk

Revised version received 26 March 2004
Accepted for publication 6 April 2004

Objective: To determine whether social inequalities in height change across generations.
Methods: The target population was from the 1958 British birth cohort, all born 3rd–9th March 1958, followed to 1991, and the offspring of one third of this population. Main outcomes were height measured at 7, 11, 16, and 33 years (cohort members) and once at 4–18 years (offspring). Multilevel models applied to associations of social class of origin with (a) child-to-adult growth trajectory (cohort members), (b) height (offspring), and (c) generational height increment.
Results: Height inequalities were observed among cohort members, with differences >2.0 cm at all ages between classes I and II, and IV and V. By adulthood, the difference in mean height had declined significantly in boys and slightly in girls. A secular trend was seen between the two generations. While male offspring had a similar mean height to their fathers in classes I and II, boys in classes IV and V gained 2.1 cm ($p<0.001$). Height gains of female offspring were evident in all classes, with a greater gain in classes IV and V (non-significant). The social class effect on height was weaker among offspring, with a difference between classes I and II, and IV and V of less than 1 cm.
Conclusions: Social inequalities in height observed among the cohort weakened substantially in the next generation due to a greater height gain among offspring from manual classes. Inequalities in childhood height have narrowed between the two generations in this study.

Secular trends in height are continuing, with increases among adults of up to 1 cm per decade in western European countries.[1] In Britain, for example, the mean trend for those born over the period from 1892 to 1958 was 1.09 cm per decade for men and 0.36 cm for women.[2] The secular change is regarded as an indicator of improving socioeconomic and health status.[1] Shorter adult stature is a well established risk factor for mortality from respiratory diseases and cardiovascular diseases,[3] although increasing stature is not advantageous for some health outcomes, such as cancer unrelated to smoking[4–8] and hip fracture.[9] Trends in height are therefore of interest in relation to a wide range of health outcomes.

Socioeconomic inequalities in height are widely reported both in developing and developed countries.[10–15] Many studies focus on adult height, but this measure may obscure the extent of delayed growth in childhood, due to the phenomenon of catch up growth. Childhood height is a better indicator of early life conditions; those with a less optimal environment in early life tend to mature later and grow for a longer period.[16] Moreover, conditions influencing growth in childhood may influence disease risk in adulthood, as suggested by studies of leg length (which is thought to be sensitive to early environment) and cardiovascular mortality, insulin resistance, and cancer.[17 18] Studies of leg length are important because they point to exposures in early childhood affecting post-natal linear growth, as potential influences on adult health outcomes. Thus, inequalities in childhood height are of particular interest. Evidence to date suggests that social inequalities in childhood height may have reduced in magnitude in recent decades,[19–22] although they still exist in several countries.[20 23–25]

In order to establish whether inequalities in height have reduced in recent years, we compare height inequalities in two generations during a period of secular increase. Using information from the 1958 British birth cohort and their offspring, we examine within and between generations to establish whether: (i) the magnitude of social differences in height varies from childhood through to full height in adulthood; (ii) social inequalities in height have changed across two generations; and (iii) the secular trend in height has occurred at a similar rate in all social groups.

METHODS

Study samples

The 1958 birth cohort includes all born in England, Scotland, and Wales from 3rd to 9th March, 1958. A target population of about 17 000 live births was followed up at ages 7, 11, 16, 23, 33, and 41 years.[26] Immigrants born in the relevant week were included in the target sample at ages 7, 11, and 16. The sample of respondents at age 33 years is generally representative of the original birth cohort.[27] We use data on 15 826 (8129 male and 7697 female) cohort members with at least one height measure between 7 and 33 years of age (92% had more than one measure) and information on parental height and social class of origin. This sample is similar to the original birth study with respect to social class of origin, with 24.6% of cohort members from classes IV and V, compared to 24.3% in the origin sample, and 19.6% from classes I and II compared to 19.5%.

By age 33, 67% of cohort members had become parents and of these a random sample of one in three was selected for a study of their children.[27] A total of 4271 offspring were identified from 2584 (1515 female, 1069 male) cohort members. Offspring aged 4 years or more were measured: 2853 (average age 8 years, range 4–18 years with 94% under 14 years) with information on the height and social class of their grandfather were included in the analyses.

Height measurements

Cohort members were measured to the nearest inch by trained medical personnel at ages 7, 11, and 16 years; self

Abbreviations: SDS, standard deviation scores

reported at 23 years; and measured at 33 years without shoes using a stadiometer reading to the nearest centimetre. Height at 33 years was used for adult height (23 years height was used if data for 33 years were missing). Heights of the offspring (≥4 years) were measured to the nearest centimetre. The cohort member's mother was measured (in inches) in 1958, whereas the father's height was reported (in inches) in 1969 when the cohort member was aged 11 years. Both measures were converted into centimetres.

Socioeconomic measures

Inequalities in height were examined using measures of socioeconomic circumstances in childhood and in adulthood. The socioeconomic origins of cohort members were represented by:

i) social class, based on father's occupation in 1965 (or at birth if missing), categorised as: (1) I and II (professional/managerial), (2) IIINM (skilled non-manual), (3) IIIM (skilled manual), and (4) IV and V (semi- or unskilled manual);
ii) housing tenure at age 7 (in 1965), categorised as: (1) owner occupier, (2) private renter, and (3) council or housing association renter.

Measures of the adult socioeconomic circumstances of the cohort member included:

i) social class, based on the cohort member's current or most recent occupation in 1991, and categorised as above;
ii) housing tenure at age 33 (in 1991), categorised as above for age 7;
iii) education level at age 33, recorded as the highest qualification in five categories: (1) no education, (2) <O level, (3) O level, (4) A level, or (5) higher than A level.

Data analysis

For the within generation analysis of inequalities in height, the socioeconomic position/height association for cohort members at different life stages was examined simultaneously using a multivariate multilevel model,[28] where individuals were treated as level-two units and each height measurement as level-one units. We have used a multivariate multilevel model to incorporate all available data, rather than restrict our analyses to participants with complete data. Analyses use height standard deviation scores (SDS) calculated for each cohort member based on the sample with data at each age, that is, internally standardised height SDS. Social differences in height were examined before and after adjustment for parental height (an average of paternal and maternal height SDS, also internally standardised). Mean height (SDS) at each age by socioeconomic group was estimated for males and females separately and then transformed to centimetres. Because of the large time interval from 16 to 33 years, which might misrepresent the rate of growth after age 16, age 20 years was used for final adult height for plotting height trajectories. Differences in height (SDS) among all socioeconomic groups and between extreme groups were tested. We further tested whether social inequalities in height differed between successive occasions (that is, between 7 and 11 years, 11 and 16 years, and 16 and 33 years).

For the comparison of inequalities across two generations, SDS were derived for height of offspring and cohort members at age of 7 using an external reference (the 1990 British growth reference[29]). The association between socioeconomic position and height in the two generations was examined using a two-level model,[28] where families were treated as level-two units and individuals (cohort members or offspring) as level-one units. The two-level model takes into account the correlation between cohort members and their offspring, and also that between offspring from the same families. Mean height SDS were estimated for socioeconomic groups and transformed to centimetres. To account for the inverse association between offspring and maternal age due to the study design, we adjusted for the child's age to remove possible confounding effects of maternal age. However, it could be argued that comparison of social differences between the two generations should be restricted to age groups at comparable stages of maturation, for example to pre-pubertal ages. We therefore repeated analyses for the offspring, splitting the sample into two groups (4–10 and 11–18 years), to establish whether social differences in height were similar for the two age groups.

In addition, analyses were repeated restricting the sample of cohort members to those with children in the offspring sample, to ensure that any differences in social inequality observed were not due to sample selection. Analyses were also repeated for alternative measures of socioeconomic position. We present information for same sex parent-offspring, although separate analyses of mother-offspring and mother-daughter pairs showed a similar height gain, and likewise for father-offspring and father-son pairs (data not presented). All analyses were performed using SAS for UNIX and MLwiN.

RESULTS

Table 1 provides a summary of selected characteristics of cohort members and their offspring. Offspring were taller on average than their parents by a standard deviation score of 0.19 in boys and 0.23 in girls, equivalent to 1.0 and 1.2 cm, respectively, at 7 years. Changes in mean birth weight were negligible, but fewer offspring lived in larger families (<10% *v* 30% with more than three children).

Comparing inequalities in height within the generation of cohort members shows social class differences in mean height at each age of measurement from childhood to adulthood (table 2). Mean height increased incrementally with social class and differences between classes I and II, and IV and V exceeding 2 cm at all ages. Figure 1 shows that the association between height and social class varies by age. Among boys, the effect of social class was strongest until age

Table 1 Selected characteristics of cohort members (aged 7 years) and their offspring (aged 4–18 years)

Characteristic	Cohort members (n = 13 375)	Offspring (n = 2853)
Sex, n (%)		
Boys	6894 (51.5)	1406 (49.3)
Girls	6481 (48.5)	1447 (50.7)
Maternal age (years), mean (range)	27.5 (14–47)	24.4 (15–38)
<30 years, n (%)	8669 (66.5)	2718 (98.1)
≥30 years, n (%)	4361 (33.5)	52 (1.9)
Family size, n (%)		
1	1161 (8.7)	295 (10.3)
2	4703 (35.3)	1469 (51.5)
3	3499 (26.3)	803 (28.1)
≥4	3948 (29.7)	286 (10.0)
Birth weight, mean (SD)		
Boys	3409 (524)	3361 (552)
Girls	3268 (511)	3252 (529)
Height SDS, mean (SD)*		
Boys	−0.202 (1.08)	−0.010 (1.06)
Girls	−0.251 (1.11)	−0.023 (1.07)
Total	−0.228 (1.09)	−0.017 (1.06)

*Standardised against the 1990 British growth reference.

11 years, with a difference in height (SDS) between classes I and II, and IV and V of 0.48 at 11 years reducing significantly to 0.36 in adulthood ($p<0.001$). Thus boys in classes IV and V had a faster growth rate throughout adolescence than their peers in classes I and II and continued growing, possibly for a longer period, after age 16. For girls, social differences in height (SDS) fluctuated with age, with first a decrease from ages 7 to 11 years and then an increase to age 16, declining thereafter. Social class differences reduced after adjusting for parental height, though remaining significant at all ages (fig 1). In adulthood, the adjusted difference was 0.7 cm for men and 1.1 cm for women.

Inequalities in childhood height, compared across the two generations, are presented in tables 3 and 4. Estimates of mean height (SDS) of cohort members and offspring are shown by socioeconomic group, first with measures of the cohort members' childhood origins (table 3) and, second, with measures of their adult circumstances (table 4). While cohort members showed differences in height SDS between classes I and II, and IV and V of 0.52 (2.7 cm) and 0.45 (2.3 cm) for boys and girls, respectively, in the offspring differences of 0.12 (0.6 cm) and 0.16 (0.8 cm), respectively, were non-significant (table 3). To assess whether social differences between the two generations reflected differences in the age groups studied, we repeated analyses for the offspring, splitting the sample into two groups (4–10 and 11–18 years). We found identical results for males, namely a 0.12 (0.6 cm) class difference for both age groups. For females, a class difference of 0.15 (0.8 cm) was found for the 4–10 year age group, which was close to the full offspring sample, with a difference of 0.26 (1.3 cm) in the 11–18 year group. These results confirm that the narrowing inequalities in height observed between generations was not affected by comparing a pre-pubertal group (7 years) with a mixed pre- and post-pubertal group (4–18 years), that is the narrowing was evident when comparing pre-pubertal groups. Further, we examined whether the narrowing in social class differences in height between generations persisted after adjusting for parental height and found that this was the case: for cohort members the adjusted differences were 0.29 (1.5 cm) and 0.25 (1.3 cm) for boys and girls, respectively, while in the offspring there was no difference between classes I and II, and IV and V. A narrowing of height differences was also found for housing tenure, with no significant association among offspring. Mean height differences between children from owner occupier and council rented accommodation reduced significantly from 2.0 cm for cohort members (boys and girls) to 0.7 and 0.5 cm, respectively in their offspring (table 3).

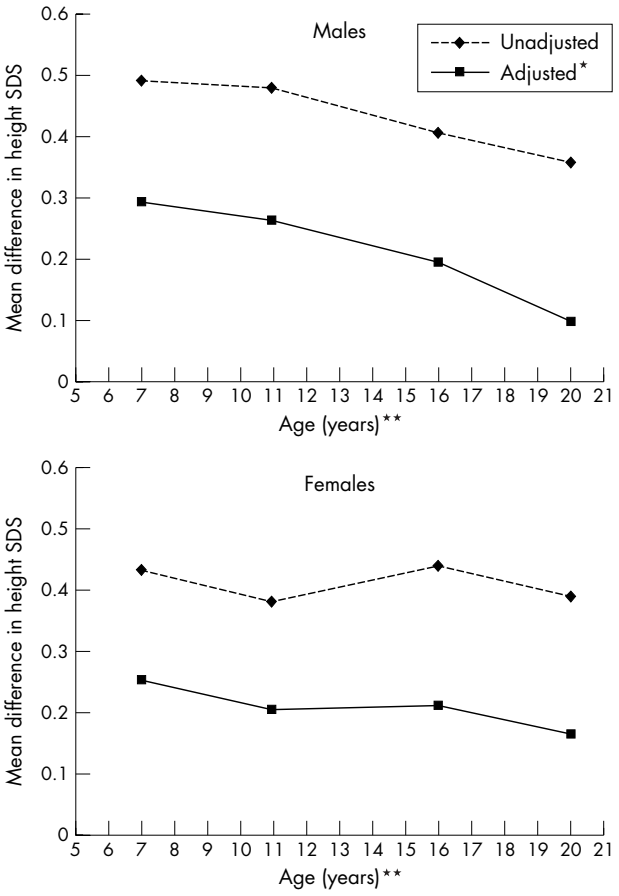

Figure 1 Difference in mean height SDS between classes I and II, and IV and V. Differences in mean height between two extreme classes at all ages were estimated from multilevel modeling. *Adjusted for parental height. **Adult height measured at age 33 years and plotted at age 20.

Similarly, a reduction in inequalities in height is seen with measures of the cohort member's adult (33 years) socio-economic position (table 4). Mean height for cohort members at 7 years differed between classes I and II, and IV and V by 2.1 cm for boys and 2.0 cm for girls, reducing significantly to 0.7 cm among their offspring (boys and girls). Mean height differences also reduced though remaining significant using adult housing tenure of the cohort member; and for education level differences reduced but were still significant

Table 2 Mean height† in cm (n) for cohort members at ages 7, 11, 16, and 33 by social class in 1965

	Social class				
	I and II	IIINM	IIIM	IV and V	
Age	Mean (n)	Mean (n)	Mean (n)	Mean (n)	d (SE)*
Boys					
7	124.4 (1384)	123.5 (675)	122.5 (3145)	121.5 (1690)	2.9 (0.20)
11	145.7 (1246)	144.9 (630)	143.6 (2864)	142.4 (1547)	3.3 (0.24)
16	172.0 (1086)	171.2 (566)	169.8 (2433)	168.7 (1291)	3.2 (0.29)
33	178.1 (1363)	177.6 (687)	176.5 (3040)	175.7 (1656)	2.4 (0.24)
Girls					
7	123.4 (1290)	122.9 (680)	121.5 (2950)	120.8 (1561)	2.6 (0.22)
11	146.4 (1197)	146.0 (625)	144.3 (2732)	143.6 (1457)	2.8 (0.28)
16	162.5 (1034)	162.3 (506)	160.6 (2326)	159.7 (1218)	2.7 (0.22)
33	164.0 (1390)	163.8 (710)	162.2 (3273)	161.5 (1728)	2.5 (0.23)

*Differences between classes I and II, and IV and V, and between all four social classes are significant for each sex at all ages ($p<0.001$).
†Mean heights by social class at all ages were estimated from multilevel models.

Table 3 Mean height SDS (n) for cohort members (aged 7 years) and their offspring (aged 4–18 years) by childhood socioeconomic circumstances of the 1958 cohort (1965)*

Childhood circumstances	Cohort members (n = 13 346)		Offspring (n = 2853)	
	Boys	Girls	Boys	Girls
Social class				
I and II	0.10 (1383)	0.01 (1289)	0.08 (229)	0.14 (207)
IIINM	−0.04 (674)	−0.07 (679)	−0.02 (135)	0.09 (108)
IIIM	−0.25 (3138)	−0.32 (2942)	0.00 (649)	−0.05 (732)
IV and V	−0.42 (1686)	−0.43 (1555)	−0.04 (393)	−0.02 (400)
d†	0.52 (2.7 cm)	0.45 (2.3 cm)	0.12 (0.6 cm)	0.16 (0.8 cm)
SE	0.04 (0.2 cm)	0.04 (0.2 cm)	0.10 (0.5 cm)	0.10 (0.5 cm)
95% CI	(2.3 to 3.0 cm)	(1.9 to 2.7 cm)	(−0.3 to 1.6 cm)	(−0.1 to 1.8 cm)
p Value	<0.001	<0.001	0.17	0.08
Housing tenure				
Owner occupied	−0.03 (2937)	−0.06 (2762)	0.03 (476)	0.04 (448)
Private rental	−0.15 (1208)	−0.26 (1112)	0.18 (215)	0.04 (238)
Social housing	−0.41 (2693)	−0.45 (2559)	−0.10 (592)	−0.06 (604)
d†	0.38 (2.0 cm)	0.38 (2.0 cm)	0.13 (0.7 cm)	0.10 (0.5 cm)
SE	0.02 (0.1 cm)	0.03 (0.2 cm)	0.07 (0.4 cm)	0.07 (0.4 cm)
95% CI	(1.7 to 2.2 cm)	(1.7 to 2.3 cm)	(−0.1 to 1.3 cm)	(−0.2 to 1.2 cm)
p Value	<0.001	<0.001	0.06	0.16

*Height SDS for cohort members at 7 years and offspring are based on the 1990 British growth reference,[29] and the estimates are from multilevel modelling and adjusted for age for the offspring.
†Differences between classes I and II, and IV and V, estimates presented here may vary slightly from table 2 because of the small difference in sample and the different height reference data used for the derivation of height SDS.

among male offspring, with a difference of 2.1 cm between those with no qualification and higher than O level. It should be noted that sample size was smaller for offspring than for cohort members (tables 3 and 4). We therefore estimated socioeconomic differences for cohort members using the sample size for the offspring and effects remained significant. Thus, the change in height inequalities between generations cannot be attributed to differences in sample size.

Comparing mean heights (SDS) across generations and within socioeconomic groups shows that the secular increase varied considerably, with larger increases for those in the least advantaged circumstances and negligible changes for the most advantaged (tables 3 and 4). To illustrate, a mean increase of 2.3 cm (boys) and 2.1 cm (girls) was observed in classes IV and V, but there was no increase in boys and a small increase of 0.7 cm in girls in classes I and II (table 3). When we repeated the analyses for cohort members who were parents of children in the offspring sample we found a similar trend of narrowing in height inequalities between the generations. Within families, the height gain of offspring relative to their parents varied by social class (fig 2). In classes I and II, sons had a similar height on average to their fathers, while in classes IV and V there was an increase of 2.1 cm ($p<0.001$). Gains in height of daughters relative to mothers were evident in all social classes, albeit a greater height gain in classes IV and V was not significant ($p = 0.12$).

Table 4 Mean height SDS (n) for cohort members (aged 7 years) and their offspring (aged 4–18 years) by adult socioeconomic circumstances of the 1958 cohort (1991)*

Adult circumstances	Cohort members (n = 11 077)		Offspring (n = 2807)	
	Boys	Girls	Boys	Girls
Social class				
I and II	−0.01 (1963)	−0.09 (1614)	0.05 (359)	0.05 (337)
IIINM	−0.08 (644)	−0.18 (2153)	0.10 (385)	0.01 (420)
IIIM	−0.28 (1939)	−0.35 (446)	−0.03 (256)	0.06 (260)
IV and V	−0.41 (1008)	−0.47 (1310)	−0.09 (379)	−0.09 (411)
d	0.41 (2.1 cm)	0.38 (2.0 cm)	0.15 (0.7 cm)	0.13 (0.7 cm)
95% CI	(1.7 to 2.5 cm)	(1.6 to 2.4 cm)	(−0.1 to 1.6 cm)	(−0.1 to 1.5 cm)
p Value	<0.001	<0.001	0.07	0.10
Housing tenure				
Owner occupied	−0.09 (3301)	−0.18 (3456)	0.08 (1024)	0.08 (1028)
Private rental	−0.19 (245)	−0.23 (236)	−0.05 (54)	0.42 (64)
Social housing	−0.50 (511)	−0.52 (715)	−0.23 (327)	−0.12 (340)
d	0.40 (2.1 cm)	0.34 (1.8 cm)	0.31 (1.6 cm)	0.20 (1.0 cm)
95% CI	(1.6 to 2.6 cm)	(1.3 to 2.2 cm)	(0.9 to 2.3 cm)	(0.3 to 1.7 cm)
p Value	<0.001	<0.001	<0.001	<0.01
Education level				
None	−0.54 (395)	−0.76 (457)	−0.26 (185)	−0.11 (190)
<O level	−0.31 (576)	−0.39 (778)	0.03 (258)	0.04 (269)
O level	−0.22 (1063)	−0.21 (1691)	0.01 (472)	0.00 (474)
A level	−0.17 (1094)	0.01 (481)	0.02 (211)	−0.01 (209)
Higher	0.07 (1316)	−0.06 (1199)	0.15 (251)	0.04 (274)
d	0.61 (3.1 cm)	0.71 (3.6 cm)	0.41 (2.1 cm)	0.15 (0.8 cm)
95% CI	(2.6 to 3.7 cm)	(3.0 to 4.0 cm)	(1.01 to 3.2 cm)	(−0.3 to 1.8 cm)
p Value	<0.001	<0.001	0.002	0.16

*Height SDS for cohort members at 7 years and offspring are based on the 1990 British growth reference,[29] and the estimates are from multilevel modelling and adjusted for age of the offspring.

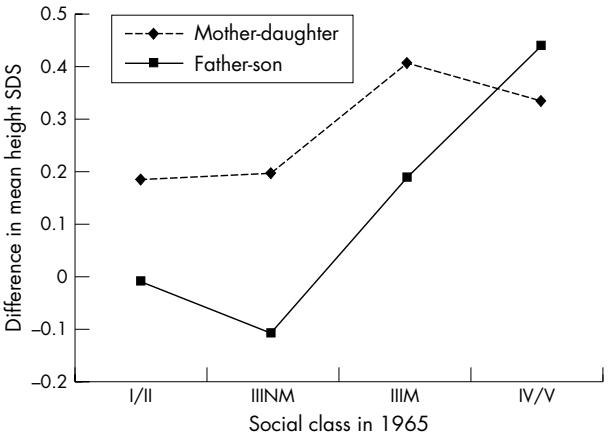

Figure 2 Difference in mean childhood height (SDS) between offspring (4–18 years) and their parents (7 years) by social class in 1965. Differences in all classes were estimated from multilevel modeling, adjusting for age of the offspring.

DISCUSSION

Strong social inequalities in height were evident in a generation born in 1958. The association was established from the earliest age of measurement, at 7 years, attenuating slightly thereafter through to adulthood and after allowance for parental height. The secular trend was evident, with an increase in childhood height of about 1 cm between generations, but inequality in height was not reproduced to the same extent in the younger generation. Our main finding was that social inequalities in childhood height had narrowed: a mean difference in height between classes I and II, and IV and V of more than 2 cm among cohort members, reduced to less than 1 cm among their offspring. The narrowing of childhood height inequalities over time was mainly due to a greater height gain among those in less advantaged circumstances.

Methodological considerations

The 1958 birth cohort is representative of the general population,[27 30] has a large sample followed over a long period of time, with relevant data across two generations. Such data allow us to examine the association throughout childhood to adulthood within a generation and also to explore intergenerational associations between socioeconomic position and height in successive generations. Information is scarce on trends in inequalities in childhood height and so these data present an important opportunity to assess recent trends. However, the offspring are a generation born to cohort members before their 30th birthday and are not a randomly selected sample from the population. They have younger mothers (24.4 years) compared to the general population, which in 1986 was 27.0 years,[31] though lone mothers are under-represented (8.0%) compared to national data for 1991 (16.6%).[32] But most importantly, the offspring resemble the general population with respect to birth weight, social class,[33] and height.[29] Moreover, any small sample biases are unlikely to affect the comparisons of parent-offspring height gain between social groups.

We used a multivariate multilevel model to take account of the correlations between measures from the same individual. This model has the flexibility to deal with incomplete data on response variables, such that subjects with at least one height measure could be included in the analysis. Two-level models were used for the comparison between two generations taking into account the within family correlations.

Within generations: the development of height inequalities

Previous studies have reported inequalities in height in both childhood[2 19 20 23–25] and adulthood,[11–13 15 34 35] though with varying magnitude. For example, in childhood we found a difference between classes I and II, and IV and V at age 7 of 2–3 cm, whereas the difference between 7 year olds from non-manual and manual backgrounds was 2.3 cm (boys) and 2.4 cm (girls) among the 1946 British cohort, and 1.2 cm (boys) and 2.6 cm (girls) in a more recent sample born in 1980/81 (Nine Towns Study).[2] In adulthood, social differences in height in the 1958 cohort were 2.4 cm for men and 2.5 cm for women. A study of 10 European countries reported average height differences between two broad educational groups (⩾upper secondary level *v* <upper secondary level) ranging from 1.6 to 3.0 cm in men and 1.2 to 2.2 cm in women.[15]

Although inequalities in height are well documented, there is to our knowledge no previous study demonstrating how the association changes across the life course. It is particularly notable that inequalities in height were already well established by age 7 and that they reduced in magnitude with the attainment of full adult stature. Potentially, the extent of height inequality at different ages might vary because of social mobility linked to height, as seen in this cohort[36] and elsewhere.[37] In the present study, however, the slight attenuation in inequalities that occurred with the achievement of adult height cannot be attributed to social mobility, because all comparisons across age were based on a fixed social measure in childhood. Thus, the trend with age suggests that catch up growth and an extension of the growth period are responsible for some of the reduction in inequality, as suggested by others.[16 21] For this generation born in 1958 it appears that social differences in childhood height are partly due to differences in growth tempo, with socioeconomic position not only influencing height at a certain age, but growth tempo and timing of maturation, as well as final height.[38] Not surprisingly, height inequalities in our study were partially attenuated after adjustment for parental height, though significant associations with social position remained, suggesting that socioeconomic conditions in early life have influenced the trends in growth of this cohort.

Between generations: narrowing inequalities in height

Offspring were about 1 cm taller on average than their parents, reflecting the secular increase documented for recent decades.[1 2 39] The estimate for females is comparable with other studies,[2] and a 1 cm increase for males over a period of about 26 years is comparable with the increase among 7 year old English boys (1.1 cm) in the National Study of Health Growth study between 1972 and 1994,[40] but less than the 1 cm per decade reported elsewhere.[1] Some evidence is also available on trends in height inequalities over time,[2 19–22 34 41 42] though it is more scarce. Our main finding is that inequalities in childhood height have narrowed, as illustrated by a reduction in social differences (classes I and II *v* IV and V) from 2–3 cm at age 7 years for those born in 1958, to less than 1 cm for a generation born about 26 years later. The narrowing trend in inequality was seen with occupational class and also with alternative socioeconomic measures. Other studies suggest that height inequalities are diminishing in Western countries,[19–22 34 42] though fluctuations and inconsistent trends have been observed.[2 20 24 43] It is notable that in our study, the secular increase in height was stronger in unskilled manual classes and less so in professional and managerial classes. This differential intergenerational height gain appears to follow the pattern shown previously

for men in a comparison of the 1958 cohort and an earlier generation.[44] Elsewhere, greater secular increases in height have been observed among less advantaged groups.[45–48]

While the growth of those born in 1958 was clearly influenced by their childhood social conditions, the evidence from the intergenerational comparison with their offspring suggests that effects of social conditions have lessened over time. The explanation for this trend may not be straightforward. Sociodemographic change may have played a part, since there were reductions in family size over the period of study. But the role of income inequality is not easily discerned. Improvements in the standard of living have not abolished income disparities, with children in particular experiencing increased rates of poverty.[49] However, diminishing height inequality may also reflect the quality of welfare provision during the 1960s and 1970s. Welfare policy is not easily assessed, but perhaps the better growth of children in less advantaged groups reflects the provision of safety nets for such groups. Whatever the explanation, our results suggest that future trends in inequality in health linked to childhood growth are likely to show some improvements.

Authors' affiliations

L Li, C Power, Centre for Paediatric Epidemiology and Biostatistics, Institute of Child Health, 30 Guilford Street, WC1N 1EH London, UK
O Manor, School of Public Health and Community Medicine, Hebrew University, Hadassah, POB 12272, Jerusalem 91120, Israel

Conflict of interest: none declared.

REFERENCES

1 **Cole TJ**. Secular trends in growth. *Proc Nutr Soc* 2000;**59**(2):317–24.
2 **Kuh DL**, Power C, Rodgers B. Secular trends in social class and sex differences in adult height. *Int J Epidemiol* 1991;**20**(4):1001–9.
3 **Waaler HTH**. Height, weight and mortality. The Norwegian experience. *Acta Med Scand* 1984;**679**(S):1–56.
4 **Leon DA**, Davey-Smith G, Shipley M, *et al*. Adult height and mortality in London: early life, socio economic confounding or shrinkage? *J Epidemiol Commun Health* 1995;**49**:5–9.
5 **Andersson SO**, Wolk A, Bergstrom R, *et al*. Body size and prostate cancer: a 20-year follow-up study among 135 006 Swedish construction workers. *J Natl Cancer Inst* 1997;**89**(5):385–9.
6 **Frankel S**, Gunnell DJ, Peters TJ, *et al*. Childhood energy intake and adult mortality from cancer: the Boyd Orr Cohort Study. *BMJ* 1998;**316**(7130):499–504.
7 **Gunnell DJ**, Smith GD, Holly JM, *et al*. Leg length and risk of cancer in the Boyd Orr cohort. *BMJ* 1998;**317**(7169):1350–1.
8 **Davey-Smith G**, Hart C, Upton M, *et al*. Height and risk of death among men and women: aetiological implications of associations with cardiorespiratory disease and cancer mortality. *J Epidemiol Commun Health* 2000;**54**(2):97–103.
9 **Meyer HE**, Tverdal A, Falch JA. Risk factors for hip fracture in middle-aged Norwegian women and men. *Am J Epidemiol* 1993;**137**(11):1203–11.
10 **Lindgren G**. Height, weight and menarche in Swedish urban school children in relation to socio-economic and regional factors. *Ann Hum Biol* 1976;**3**(6):501–28.
11 **Rosenbaum S**, Skinner RK, Knight IB, *et al*. A survey of heights and weights of adults in Great Britain, 1980. *Ann Hum Biol* 1985;**12**(2):115–27.
12 **Bielicki T**, Waliszko A, Hulanicka B, *et al*. Social-class gradients in menarcheal age in Poland. *Ann Hum Biol* 1986;**13**(1):1–11.
13 **Kuh DL**, Wadsworth M. Parental height: childhood environment and subsequent adult height in a national birth cohort. *Int J Epidemiol* 1989;**18**(3):663–8.
14 **Sichieri R**, Taddei JA, Everhart JE. Influence of parental height and sociodemographic factors on adolescent height in Brazil. *J Adolesc Health* 2000;**26**(6):414–9.
15 **Cavelaars AE**, Kunst AE, Geurts JJ, *et al*. Persistent variations in average height between countries and between socio-economic groups: an overview of 10 European countries. *Ann Hum Biol* 2000;**27**(4):407–21.
16 **Eveleth PB**, Tanner JM. Environmental influences on growth. In: *Worldwide variation in human growth*. 2nd ed. Cambridge: Cambridge University Press, 1990:191–207.
17 **Gunnell DJ**, Davey Smith G, Frankel S, *et al*. Childhood leg length and adult mortality: follow up of the Carnegie (Boyd Orr) survey of diet and health in pre-war Britain. *J Epidemiol Commun Health* 1998;**52**:142–52.
18 **Davey-Smith D**, Greenwood R, Gunnell D, *et al*. Leg length, insulin resistance, and coronary heart disease risk: the Caerphilly Study. *J Epidemiol Commun Health* 2001;**55**(12):867–72.
19 **Brundtland GH**, Liestol K, Walloe L. Height, weight and menarcheal age of Oslo schoolchildren during the last 60 years. *Ann Hum Biol* 1980;**7**(4):307–22.
20 **Lindgren GW**, Cernerud L. Physical growth and socioeconomic background of Stockholm schoolchildren born in 1933–63. *Ann Hum Biol* 1992;**19**(1):1–16.
21 **Kromeyer K**, Hauspie RC, Susanne C. Socioeconomic factors and growth during childhood and early adolescence in Jena children. *Ann Hum Biol* 1997;**24**(4):343–53.
22 **Prebeg Z**. Changes in growth patterns in Zagreb school children related to socio-economic background over the period 1973–1991. *Ann Hum Biol* 1998;**25**(5):425–39.
23 **Goldstein H**. Factors influencing the height of seven-year-old children. Results from the National Child Development Study (1958 cohort). *Hum Biol* 1971;**43**:92–111.
24 **Cernerud L**. Differences in height between socially more and less privileged 10 year old Stockholm children born in 1933–1963. *Scand J Soc Med* 1992;**20**(1):5–10.
25 **Jansen W**, Hazebroek-Kampschreur AA. Differences in height and weight between children living in neighbourhoods of different socioeconomic status. *Acta Paediatr* 1997;**86**(2):224–5.
26 **Centre for Longitudinal Studies, Institute of Education, University of London**. National Child Development Study composite file including selected perinatal data and sweeps one to five [computer file]. National Birthday Trust Fund, National Children's Bureau, City University Social Statistics Research Unit [original data producers]. Colchester, Essex: The Data Archive [distributor]. SN:3148. 1994.
27 **Ferri E**. *Life at 33: the fifth follow-up of the National Child Development Study*. London: National Children's Bureau, 1993.
28 **Goldstein H**. *Multilevel statistical models*, 2nd ed. New York: Wiley, 1995.
29 **Freeman JV**, Cole TJ, Chinn S, *et al*. Cross sectional stature and weight reference curves for the UK, 1990. *Arch Dis Child* 1995;**73**(1):17–24.
30 **Power C**, Manor O, Fox AJ. *Health and class: the early years*. London: Chapman and Hall, 1991.
31 **Central Statistical Office**. *Social Trends*, Vol 21. 21st ed. London: CSO, 1991.
32 **Haskey J**. Trends in the numbers of one-parent families in Great Britain. *Popul Trends* 1993;**71**:26–33.
33 **OPCS**. *Mortality Statistics. Perinatal and infant: social and biological factors 1991*, Series DH3 no.25. London: HMSO, 1991.
34 **Nystrom Peck AM**, Vagero DH. Adult body height and childhood socioeconomic group in the Swedish population. *J Epidemiol Commun Health* 1987;**41**(4):333–7.
35 **Nystrom Peck AM**, Lundberg O. Short stature as an effect of economic and social conditions in childhood. *Soc Sci Med* 1995;**41**(5):733–8.
36 **Power C**, Manor O, Li L. Are inequalities in height underestimated by adult social position? Effects of changing social structure and height selection in a cohort study. *BMJ* 2002;**325**(7356):131–4.
37 **Bielicki T**, Waliszko H. Stature, upward social mobility and the nature of statural differences between social classes. *Ann Hum Biol* 1992;**19**(6):589–93.
38 **Tanner JM**. *A history of the study of human growth*. Cambridge: Cambridge University Press, 1981.
39 **Takaishi M**. Secular changes in growth of Japanese children. *J Pediatr Endocrinol* 1994;**7**(2):163–73.
40 **Hughes JM**, Li L, Chinn S, *et al*. Trends in growth in England and Scotland, 1972 to 1994. *Arch Dis Child* 1997;**76**(3):182–9.
41 **Teasdale TW**, Sorensen TI, Owen DR. Fall in association of height with intelligence and educational level. *BMJ* 1989;**298**(6683):1292–3.
42 **Mackenbach JP**. Narrowing inequalities in children's height. *Lancet* 1991;**338**(8769):764.
43 **Rona RJ**. The impact of the environment on height in Europe: conceptual and theoretical considerations. *Ann Hum Biol* 2000;**27**(2):111–26.
44 **Alberman E**, Filakti H, Williams S, *et al*. Early influences on the secular change in adult height between the parents and children of the 1958 birth cohort. *Ann Hum Biol* 1991;**18**(2):127–36.
45 **van Wieringen**. Secular growth changes. In: Falkner F, Tanner J, eds. *Human growth*. New York: Plenum Press, 1986:307–31.
46 **Bielicki T**, Malina RM, Waliszko H. Monitoring the dynamic of social stratification: statural variation among Polish conscripts in 1976 and 1986. *Am J Hum Biol* 1992;**4**:345–52.
47 **Bielicki T**, Szklarska A. Secular trends in stature in Poland: national and social class-specific. *Ann Hum Biol* 1999;**26**(3):251–8.
48 **Padez C**, Johnston F. Secular trends in male adult height 1904–1996 in relation to place of residence and parent's educational level in Portugal. *Ann Hum Biol* 1999;**26**(3):287–98.
49 **Gregg P**, Harkness S, Machin S. Poor kids: trends in the child poverty in Britain, 1968–96. *Fiscal Studies* 1999;**20**(2):163–87.